Attorney's Docket No.: 110348-134848
IPN: P17805

Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application for:	Examiner: Brenda A. Lamb
Valery Dubin, et al.	Art Group: 1734
Application No.: 10/763,470	Confirmation No.: 6669
Filed: 01/22/2004	
For: ELECTROLESS PLATING SYSTEMS AND METHODS	

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Declaration of Inventor Pursuant to 37 C.F.R. § 1.131

Madam:

We, Valery M. Dubin and Chin-Chang Cheng, hereby declare that:

1. At the time of the invention, we were citizens of the United States of America and the Republic of China (Taiwan), respectively, and were residents of the State of Oregon, residing in or around the greater Portland metropolitan area.

2. We are the joint inventors of the subject matter of pending claim 5, and pending claims 6-8 through their dependencies to claim 5, of the above-captioned application, as originally declared on or around December 24, 2003 in the combined declaration and power of attorney, filed on or around January 22, 2004.

3. At the time of the invention, we were employed by Intel Corporation of Santa Clara, California, the assignee. Intel Corporation is an internationally recognized company that files well over two thousand patent applications annually.

4. To the best of our recollection and as refreshed by attached **Exhibit I**, the subject invention was conceived at least on or prior to July 8, 2003. **Exhibit I** is a photocopy of an Inventor Disclosure Forms dated July 8, 2003, June 20, 2003 and June 26, 2003.

5. We additionally declare that we worked diligently with our colleagues in the Intel Legal department and our outside patent counsel from at least prior to August 28, 2003, until the filing date of the above-captioned application on January 22, 2004, to constructively reduce our invention to practice with the filing of the above-captioned application. This diligence is supported by the fact that the Inventor Disclosure Forms (**Exhibit I**) describing the subject matter of the above-captioned application was received by Intel's PPG/TMG-Packaging Patent Committee sometime after mentors' review. The Patent Committee then reviewed and selected for filing the above-captioned application, and others, from among several hundred disclosures that the Patent Committee typically receives each quarter. Our employer, Intel Corporation (assignee of the application), processes from around 5000 to around 7500 such Invention Disclosure Forms submitted each year, and in committees, that meet approximately quarterly, they select for filing from among those submitted about 2500 each year. The selection, and prioritization includes selection of outside council to prepare the applications. Regarding the above-captioned case, our employer, Intel Corporation, duly retained the services of the law firm of Schwabe, Williamson & Wyatt, which in turn duly assigned one of their patent counsels on or around September 24, 2003, to draft the subject patent application, which eventually led to the filing on January 22, 2004, after several draft iterations which I reviewed, and after a standard quality review by the Intel Legal department. The September 24, 2003 date is established by **Exhibit II** which is a new client matter form from the law firm of our patent counsel, Schwabe, Williamson & Wyatt.

We further declare that all statements made herein of our own individual knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the above-identified patent application or any patent issued thereon.

Executed by and on the date(s) as set forth below:

By:_____
Valery M. Dubin

Date: 26 December 2007

By:_____
Chin-Chang Cheng

Date:_____

INTEL CONFIDENTIAL
Attorney-Client Privileged Communication

TMG INVENTION DISCLOSURE
Located at: http://legal.intel.com/patent/IDF.asp
Rev. 11 – March 2003

32412

DATE: 06/20/03

TMG-PROCESS/TMG/CR

It is important to provide accurate and detailed information on this form (fill in ALL areas under Inventor[s]). The information will be used to evaluate your invention for possible filing as a patent application. **When the disclosure is complete, please submit electronically via e-mail to your supervisor/manager, who should then forward the disclosure along with their approval to the email account "invention disclosure submission."** If you have any questions regarding this form, please call **503-264-0444**.

Fill out the below and follow the instructions:

1. **Field of the Invention:**

- ☐ **Semiconductor Process: device and integration**
- X **Semiconductor Process + Equipment: thin films**
- ☐ **Semiconductor Process + Equipment: etch/litho**
- ☐ **Circuit Design**
- ☐ **Flash**
- ☐ **Test**
- ☐ **CQN (Q&R)**
- ☐ **Packaging**
- ☐ **Boards/Cartridge**
- ☐ **Automation**
- ☐ **Optical/MEMS/Bio-MEMS**
- ☐ **Other** _____

2. **Concise Title of Invention:**
In-line process control of Point-of-Use (POU) electroless plating tools.

3. **Brief description of invention (please use only space provided and font #10 or larger). Write the key elements of the invention (EXPLAIN HOW YOU DETECT INFRINGEMENT):**

The invention is:

Methods of on-line process control of electroless bath performance before dispensing chemical solution on the wafer by diverging/routing solution plating bath flow to a process control module to perform electroless bath qualification by using in-situ thickness measurement technique-Quart Crystal Microbalance (QCM), in-situ nucleation time measurements - open circuit potential (OCP) change and QCM, in-situ liquid particles measurements and In-situ pH monitoring.

The key elements are:

1. In-line process control for POU (point of use) style systems before dispensing chemical solution on the wafers with chemical solution diverging/routing to a process control module to perform in-situ analytical measurements
2. Use of Quart Crystal Microbalance (QCM) for monitoring of adsorption and deposition rate
3. Application of open circuit potential (OCP) change to monitor nucleation time
4. Use of pH probe to measure POU bath pH
5. Use of particle counter to monitor particle generation in the bath
6. Electroless deposition system containing POU mixing module, process module, automation, wafer handling module and in-situ process control module

EXPLAIN HOW TO DETECT INFRINGEMENT (I.E. HOW YOU DETERMINE IF SOMEONE IS USING YOUR INVENTION):

Infringement would consist of another party creating an electroless plating process using similar HW and process steps as the ones described herein. Detection would occur through vendors's interaction with their electroless cobalt plating customers and Intel's interaction with electroless suppliers.

4. **Inventor(s):**

Last Name: Cheng	First Name: Chin-Chang		M.I.
Intel Phone Number: (503) 613-6262	Intel Fax Number: (971) 214-7805		Mailstop: RA3-252
E-mail address: chin-chang.cheng@intel.com			WWID: 10655091
Citizenship: Rep. Of China (Taiwan)	Are you a contractor?	Yes:	No: X
Home Address: 6160 NW 165th Terrace			
City: Portland	State: OR	Zip: 97229	Country: USA
Corporate Level Group: TMG	Division: ATD ___ ATM ___ CR _X__ CTM ___ CQN ___ FSM ___ LTD ___ MTO ___ PMG ___ SMTD ___ STTD ___ TCAD ___ TME ___ Other _____		
Supervisor: Valery Dubin	WWID: 10585050	M/S: RA3-252	Phone #: 613-4784

Last Name: Dubin	First Name: Valery		M.I.
Intel Phone Number: (503) 613-4784	Intel Fax Number: (971) 214-7805		Mailstop: RA3-252
E-mail address: valery.m.dubin@intel.com			WWID: 10585050
Citizenship: USA	Are you a contractor?	Yes:	No: X
Home Address: 5388 NW Lianna Way			
City: Portland	State: OR	Zip: 97229	Country: USA
Corporate Level Group: TMG	Division: ATD ___ ATM ___ CR _X__ CTM ___ CQN ___ FSM ___ LTD ___ MTO ___ PMG ___ SMTD ___ STTD ___ TCAD ___ TME ___ Other _____		
Supervisor: Ken David	WWID: 10038967	M/S: RA3-252	Phone #: 613-6620

Last Name:	First Name:		M.I.
Intel Phone Number:	Intel Fax Number:		Mailstop:
E-mail address:			WWID:
Citizenship:	Are you a contractor?	Yes:	No:
Home Address:			
City:	State:	Zip:	Country:
Corporate Level Group: TMG	Division: ATD ___ ATM ___ CR ___ CTM ___ CQN ___ FSM ___ LTD ___ MTO ___ PMG ___ SMTD ___ STTD ___ TCAD ___ TME ___ Other _____		
Supervisor:	WWID:	M/S:	Phone #:

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

REDACTED

10. **Explain the problem being addressed by the invention:**

This invention addresses the problem of:

1. Serves as early detection system of the electroless process on POU style wafer processing tool prior to commitment of product wafers.
2. Provide a mean for on-line process adjustment

11. **Explain current state of the art (i.e, how the problem is solved today):**

Presently the problem described above is solved by:

For point-of-use systems such as spray, Microcell (trade mark of Novellus) and spin on, no process control techniques are present as part of the tool, as the ratio of the incoming chemicals feeds were pre-determined. The quality of plating process is evaluated post wafer processing by using in fab metrology techniques such as X-rays spectroscopy, acoustic spectroscopy and scanning electron microscope (SEM). The plating quality is also measured out of fab by similar techniques such as X-rays spectroscopy, acoustic spectroscopy, scanning electron microscope (SEM), tunneling electron microscopy (TEM), SIMs, XPS Auger and TOF-SIMS. Processing time of these analytical techniques is normally time consuming with long queue time and particularly after the fact that the wafers have been plated which may result in large number of wafers to be scrapped in case of process excursion.

12. **Explain technical advantages of the invention over current state of the art:**

The technical advantage of this invention is:

1. Ability to assess, and adjust, process performance of EL bath at the processing tool prior to wafer commitment.
2. Reduces wafer scrap by affirming good process prior to wafer commitment
3. Allow on-line process adjustment against pre-determined window
4. Improved manufacturability of POU style tool.
5. Technique can be proliferated to any type of electroless processes.

13. **a. Is the invention experimentally verified? YES**

Open circuit voltage measurement of nucleation time has been collected for EL Co bath vs process conditions. Particle counter has been used to monitor bath changes in beaker scale. Use of Quartz crystal microbalance is known to be sensitive to adsorption and weight change and widely published in the academia.

b. Is the invention verified with simulation? No

c. If neither a. or b. above, then you can get a patent on the concept, but please explain the technical basis to justify that your invention will work (use extra space if necessary):

14. **Detailed Description of Invention (try to use only the space provided with font #10 or larger type. Refer to your drawings):**

The proposed invention proposes a mean for process control for a wafer processing Electroless POU tool with existing electro-analytical research techniques, pH monitoring and means of monitoring particle generation. The following steps depicts how these techniques can be used as process control:

1) Processing tool is supplied with bottle chemicals or receives bulk feed from fab chemical delivery system.
2) Various chemicals are mixed with pre-determined ratio in the tool piping system or in a temporary mixing tank, which can have a closed loop pH control system.
3) The final plating solution is then routed through an inline heater that brings solution to processing temperature. An on-board sub-micron filtration system can be part of the tool system.
4) The solution is then directed through an electronically controlled valve to the proposed process control module comprised of electroanalytical methods to check for reaction kinetics such as adsorption, nucleation and deposition rates as well as pH and particles generation count against a pre-determined success criteria. The proposed techniques includes:
   - Quart Crystal Microbalance (QCM) for monitoring of adsorption, nucleation and deposition rates based on frequency changes as a function of weight change
   - Open Circuit potential (OCP) change for monitoring substrate surface change such as nucleation time
   - pH meter for in-line pH control as mentioned in (2).
   - Optional non-electrochemical techniques such as particle counter to monitor generation of particles against a pre-set success criteria. Particle counter can also be located downstream of the process chamber, but ideal location is up-stream of the process chamber so that wafer is not committed until success criteria is met.
5) The on-line process control system described in (4) then feed the results to an on-board system controller to determine if it meet plating success criteria:
   - If meet success criteria, electronic valve will then be opened to allow solution to be delivered to the process chamber for wafer plating by spay, face-up Microcell design (Trade mark of Novellus Systems) or by spin-on.
   - If bath determined to be bad, plating will not be allowed.
   - Or the controller may send signal to adjust feed ratio, pH and process Temperature until success criteria is met to allow wafer commitment.

One embodiment of the present invention includes frequency counter, voltmeter and pH meter necessary for monitoring frequency change of QCM, open circuit potential by voltmeter and pH by the pH meter.

Referenced sketches/dwg's/diagrams: (use additional page(s)

Drawings (use as many pages as needed)
(PLEASE DO NOT MAKE COLOR DRAWINGS)

15. **Figure 1. Present State of the Art (often this is helpful to explain your invention, but it is not required).**

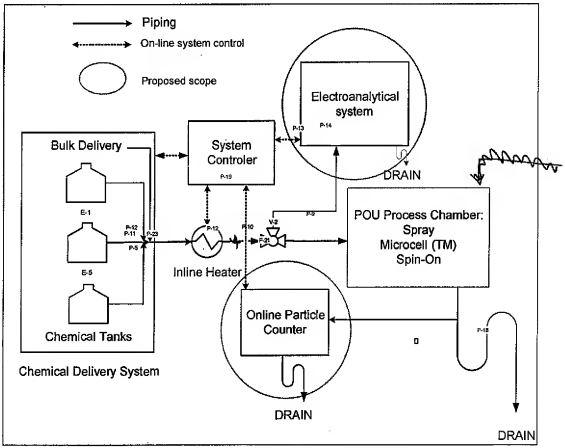


Figure 1. Proposed Electroanalytical Process Control fo POU Systems

16. **Key Supporting Data (1 page limit on separate page):**

17. **What is the product or process invention to be used on? (e.g., P8xx, name of product, etc.):**
P1266+

18. Have you reviewed your invention with a TMG Patent Mentor? (see below for mentor names) If so, give name: __Ken Cadien_____

19. Any other information the IP Committee should consider?

MENTOR REVIEW

If you don't already have a departmental peer review process for invention disclosures, we recommend you have it reviewed by a Mentor before you submit your invention disclosure. The purpose of this Mentor review is to ensure that the invention disclosure is written clearly enough for the IP Committee to comprehend your invention including all the novel aspects of it. Please refer to the list below for recommended Mentors by area. Select ONE Mentor to review and acknowledge. This recommended step is not meant to unreasonably slow down the invention disclosure process. If your Mentor fails to respond to you in a reasonable amount of time, then submit your invention disclosure.

AREA OF EXPERTISE	MENTOR NAME
Semiconductor Process-device and Integration	Mark Bohr, Robert Chau, Krishna Seshan, Valery Dubin
Semiconductor Process-thin films	Ken Cadien, Chien Chiang, Michael Goldstein
Semiconductor Process-etch/litho	Peter Silverman, Peter Charvat (etch), Yan Borodovsky (litho), George Chen (litho), Susan Holl (litho)
Fab Process Equipment	George Chen
Circuits Design	Ian Young, Greg Taylor, Clair Webb, Rajesh Galivanche
Flash	Manzur Gill, Krishna Seshan
Test	J.J. Grealish, Rajesh Galivanche, Mike Mayberry
CQN (Q&R)	Ian Young, Greg Taylor, Clair Webb, Valluri (Bob) Rao
Software/CAD	Vivek Singh, Changhong Dai
Packaging	Ravi Mahajan, Vijay Wakharkar
Boards/Cartridge	Terry Dishongh
Automation	Ross Giddings
Optical and MEMS	Valluri (Bob) Rao, Ted Zarbock, Charles Young, Kevin Reif
Legal Department Patent Attorneys	Rob Winkle, Mark Seeley, David Lundmark, George Chen (patent agent)

INTEL CONFIDENTIAL
Attorney-Client Privileged Communication

32669

TMG INVENTION DISCLOSURE
Located at: http://legal.intel.com/patent/IDF.asp
Rev. 11 – March 2003

DATE: 06/26/03 *TMG-PROCESS/TMG/CR*

It is important to provide accurate and detailed information on this form (fill in ALL areas under Inventor[s]). The information will be used to evaluate your invention for possible filing as a patent application. **When the disclosure is complete, please submit electronically via e-mail to your supervisor/manager, who should then forward the disclosure along with their approval to the email account "invention disclosure submission."** If you have any questions regarding this form, please call **503-264-0444**.

Fill out the below and follow the instructions:

1. **Field of the Invention:**

- ☐ **Semiconductor Process: device and integration**
- X **Semiconductor Process + Equipment: thin films**
- ☐ **Semiconductor Process + Equipment: etch/litho**
- ☐ **Circuit Design**
- ☐ **Flash**
- ☐ **Test**
- ☐ **CQN (Q&R)**
- ☐ **Packaging**
- ☐ **Boards/Cartridge**
- ☐ **Automation**
- ☐ **Optical/MEMS/Bio-MEMS**
- ☐ **Other** _____

2. **Concise Title of Invention:**
Electroless spray deposition method

3. **Brief description of invention (please use only space provided and font #10 or larger). Write the key elements of the invention (EXPLAIN HOW YOU DETECT INFRINGEMENT):**

The invention is:

Method of electroless spray deposition including separation of unstable electroless plating bath into several stable solutions, in-line heating and filtering of stable electroless solutions, point-of-use (POU) mixing of heated stable electroless solutions before dispensing on the wafer or directly on the rotated wafer to make un-stable electroless plating bath, drain of unstable electroless plating bath. Optionally, electroless deposited metal can be reworked in case of excursion/misprocessing by selective etching followed by chemical mechanical polishing.

The key elements are:

1. Separation of unstable electroless Co bath into several stable electroless solutions (for example electroless metal stock such as metals – Co, Cu others; complexing agents such as citric acid, EDTA others; buffer such as NH4Cl, boric acids others; pH adjuster such as KOH, TMAH others and reducing agent solutions such as DMAB, hypophosphite, formaldehyde, glyoxylic acid others)
2. In-line filtering and heating of stable electroless solutions to plating temperature (30 – 90 C)
3. Point of use mixing of heated stable electroless plating solutions to make electroless plating bath (unstable due to present of reducing agents which results metal particles reduction in the plating bath volume) and then dispensing on the wafer or mixing stable electroless solution directly on the wafer to minimize the lifetime (time of use) of unstable electroless plating bath to only plating time
4. Providing adequate flow of unstable electroless plating bath on the wafer and wafer rotation to always use fresh electroless plating bath
5. Apparatus for electroless plating containing POU mixing system of stable electroless solution, pre-clean/pre-wet solution, post-clean solution, pre-heat solution, selective etching solutions; two or more in-line heaters; process chamber with rotated wafers; drain system; wafer handling system and automation.

Optionally, rework process can be used to selectively remove electroless metal, for example for Co or Cu directly plated on barrier such as Ta or TaN). Rework can be done in the same POU tool as plating by selective etching Co in dil HCl (<5%), dil H3PO4, dil H2C2O4

Optionally, stable electroless solutions can be recirculated through the holding tank and heated with immersion or in-line heaters.

REDACTED

4. Inventor(s):

Last Name: Dubin	First Name: Valery		M.I.
Intel Phone Number: (503) 613-4784	Intel Fax Number: (971) 214-7805		Mailstop: RA3-252
E-mail address: valery.m.dubin@intel.com			WWID: 10585050
Citizenship: USA	Are you a contractor?	Yes:	No: X
Home Address: 5388 NW Lianna Way			
City: Portland	State: OR	Zip: 97229	Country: USA
Corporate Level Group: TMG	Division: ATD ___ ATM ___ CR_X__ CTM ___ CQN ___ FSM ___ LTD ___ MTO ___ PMG ___ SMTD ___ STTD ___ TCAD ___ TME ___ Other _____		
Supervisor: Ken David	WWID: 10038967	M/S: RA3-252	Phone #: 613-6620

REDACTED

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

REDACTED

10. **Explain the problem being addressed by the invention:**

This invention addresses the problem of:

1. Particle generation in unstable electroless plating baths, by (a) minimizing the time between mixing the components and delivering a homogeneous heated plating solution to the wafers; and (b) ensuring a continuously fresh electroless bath solution, by providing adequate flow of electroless plating bath and wafer rotation
2. Line yield loss because of excursion/misprocessing by using rework procedure

11. **Explain current state of the art (i.e, how the problem is solved today):**

Presently the problem described above is solved by:

There is no solution demonstrated to eliminating particles generated in the electroless plating bath. The best results were obtained by using a POU spray process. POU spray electroless metal deposition uses on-line mixing of stable electroless solutions to generate unstable electroless plating bath and on-line heating of unstable electroless plating bath. However, during heating of unstable electroless plating bath, overheating can occur and particles will be generated. Besides, on-line heating is typically taken several minutes (time to flow through on-line heater) and particles will be generated during this time in the volume of plating bath and deposited on the wafers surface.
No rework process has been demonstrated/proposed for electroless plated metals

12. **Explain technical advantages of the invention over current state of the art:**

The technical advantage of this invention is:

1. No particles generated in the plating bath since it is heated and mixed from stable electroless solutions and unstable plating bath life (time of use) is limited to the plating time (about 60 sec or less for 200 A EL Co film) which is less than particles nucleation time – about 60 sec or more.
2. Always fresh unstable electroless plating bath is used on the wafer by providing adequate flow of unstable electroless plating bath and wafer rotation
3. Misprocessed electroless plating metal can be selectively removed in the same spray tool by using selective etching
4. Yield is increased due to leakage current reduction (metal particles causing leakage between lines are eliminated)

13. **a. Is the invention experimentally verified? YES**

Minimizing lifetime/time of use of unstable electroless plating bath will eliminate/reduce particles generation in the volume because particles number and size depends on the plating bath life/time of use as it has been demonstrated experimentally. Selective etching has been demonstrated in WE lab

b. Is the invention verified with simulation? No

c. If neither a. or b. above, then you can get a patent on the concept, but please explain the technical basis to justify that your invention will work (use extra space if necessary):

14. **Detailed Description of Invention (try to use only the space provided with font #10 or larger type. Refer to your drawings):**

Invention can be practice by using the following process steps:

1. Separation of unstable electroless Co bath into several stable chemical solutions (for example electroless metal stock such as metals – Co, Cu others; complexing agents such as citric acid, EDTA others; buffer such as NH4Cl, boric acids others; pH adjuster such as KOH, TMAH others and reducing agent solutions such as DMAB, hypophosphite, formaldehyde, glyoxylic acid others)
2. Bulk delivery or canisters delivery of stable electroless solution to the plater.
3. In-line filtering and heating of stable electroless solutions to plating temperature (30 – 90 C)
4. Point-of-use mixing of heated stable electroless plating solutions to make electroless plating bath (unstable due to present of reducing agents which reduces metal particles in the bath volume)
5. Dispensing on the wafer or mixing stable electroless solution directly on the wafer to minimize the lifetime (time of use) of unstable electroless plating bath to only plating time or less.
6. Providing adequate flow of unstable electroless plating bath (1.5 or more l/min) and rotating wafer (wafers) with >10 rpm in the process chamber to always have supply of fresh unstable electroless plating bath
7. Drain of unstable electroless plating bath
8. Rinse and dry wafers

Pre-clean/pre-wet can be used before dispensing electroless plating bath on the wafer. Pre-clean solution can contains mineral acids (H2SO4, HF etc), carboxylic acid (citric, malonic etc), sulfonic acids (methane sulfonic etc), bases (ammonia, TMAH), solvent (IPA etc) as well as combination of these chemicals. Optionally surfactants such as polyethers (polyethylene glycol, polypropylene glycol), Triton X-100, RE 610, Ralufon and others can be added to pre-clean solution to increase cleaning efficiency.

Optionally, stable electroless solutions can be recirculated through the holding tank and heated with immersion or in-line heaters.

Pre-heat solution can be water or water followed by base.

Post-clean solution can be dil HF (<1%), dil citric (<10%) and others.

Rework process can be used to selectively remove electroless metal, for example for Co, rework can be done in the same spray tool as deposition by selective etching Co in dil HCl (<5%), dil H3PO4, dil H2C2O4

Apparatus for electroless plating containing POU mixing system of stable electroless solution, pre-clean/pre-wet solution, post-clean solution, pre-heat solution, selective etching solutions; two or more in-line heaters; (optionally, stable platlng solution recirculation system with the heater and filtration); enclosed and pressurized process chamber with rotated wafers; drain system; wafer handling system and automation.

Referenced sketches/dwg's/diagrams: (use additional page(s)

Drawings (use as many pages as needed)
(PLEASE DO NOT MAKE COLOR DRAWINGS)

15. ...ate of the ... is helpful to avoid ..., but it is not

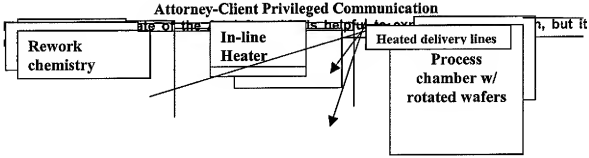


Figure 1. POU mixing of electroless bath and on-line heating

Figure 2. Schematic diagram of invention

Figure 2. Heating of stable electroless solutions and POU mixing

16. **Key Supporting Data (1 page limit on separate page):**
See section 12-15

17. **What is the product or process invention to be used on? (e.g., P8xx, name of product, etc.):**
P1266+

18. **Have you reviewed your invention with a TMG Patent Mentor? (see below for mentor names) If so, give name: Ken Cadien**

19. **Any other information the IP Committee should consider?**
Enabling IP to eliminate particles in electroless plating process

MENTOR REVIEW

If you don't already have a departmental peer review process for invention disclosures, we recommend you have it reviewed by a Mentor before you submit your invention disclosure. The purpose of this Mentor review is to ensure that the invention disclosure is written clearly enough for the IP Committee to comprehend your invention including all the novel aspects of it. Please refer to the list below for recommended Mentors by area. Select ONE Mentor to review and acknowledge. This recommended step is not meant to unreasonably slow down the invention disclosure process. If your Mentor fails to respond to you in a reasonable amount of time, then submit your invention disclosure.

AREA OF EXPERTISE	MENTOR NAME
Semiconductor Process-device and integration	Mark Bohr, Robert Chau, Krishna Seshan, Valery Dubin
Semiconductor Process-thin films	Ken Cadien, Chien Chiang, Michael Goldstein
Semiconductor Process-etch/litho	Peter Silverman, Peter Charvat (etch), Yan Borodovsky (litho), George Chen (litho), Susan Holl (litho)
Fab Process Equipment	George Chen
Circuits Design	Ian Young, Greg Taylor, Clair Webb, Rajesh Galivanche
Flash	Manzur Gill, Krishna Seshan
Test	J.J. Grealish, Rajesh Galivanche, Mike Mayberry
CQN (Q&R)	Ian Young, Greg Taylor, Clair Webb, Valluri (Bob) Rao
Software/CAD	Vivek Singh, Changhong Dai
Packaging	Ravi Mahajan, Vijay Wakharkar
Boards/Cartridge	Terry Dishongh
Automation	Ross Giddings
Optical and MEMS	Valluri (Bob) Rao, Ted Zarbock, Charles Young, Kevin Reif
Legal Department Patent Attorneys	Rob Winkle, Mark Seeley, David Lundmark, George Chen (patent agent)

INTEL CONFIDENTIAL
Attorney-Client Privileged Communication

32826

TMG INVENTION DISCLOSURE
Located at: http://legal.intel.com/patent/IDF.asp
Rev. 11 – March 2003

DATE: 07/08/03

TMG-PROCESS/TMG/CR

It is important to provide accurate and detailed information on this form (fill in ALL areas under Inventor[s]). The information will be used to evaluate your invention for possible filing as a patent application. **When the disclosure is complete, please submit electronically via e-mail to your supervisor/manager, who should then forward the disclosure along with their approval to the email account "invention disclosure submission."** If you have any questions regarding this form, please call **503-264-0444**.

Fill out the below and follow the instructions:

1. **Field of the Invention:**

- ☐ **Semiconductor Process: device and integration**
- X **Semiconductor Process + Equipment: thin films**
- ☐ **Semiconductor Process + Equipment: etch/litho**
- ☐ **Circuit Design**
- ☐ **Flash**
- ☐ **Test**
- ☐ **CQN (Q&R)**
- ☐ **Packaging**
- ☐ **Boards/Cartridge**
- ☐ **Automation**
- ☐ **Optical/MEMS/Bio-MEMS**
- ☐ **Other** _____

2. **Concise Title of Invention:**
Electroless deposition method with point of use water mixing and heating

3. **Brief description of invention (please use only space provided and font #10 or larger). Write the key elements of the invention (EXPLAIN HOW YOU DETECT INFRINGEMENT):**

The invention is:
Method of electroless deposition including point of use mixing of hot DI water and room temperature concentrated electroless bath followed by dispensing the hot diluted electroless bath on the wafer

The key elements are:
1. Point of use mixing hot DI water (up to 100C) and concentrated electroless Co bath
2. Dispensing diluted heated electroless Co bath (40 – 90C) on the wafer

Other electroless metals can be used such as Cu, Ni, Fe, Ru, Au, Ag, Pd, Pt etc

RT electroless Co bath can be mixed ex-situ or in the plating holding tank by mixing electroless Co stock solution and reducing agent solution. Electroless Co bath can be re-circulated or be in pressurized canisters

REDACTED

Inventor(s):

Last Name: Dubin	First Name: Valery		M.I.
Intel Phone Number: (503) 613-4784	Intel Fax Number: (971) 214-7805		Mailstop: RA3-252
E-mail address: valery.m.dubin@intel.com			WWID: 10585050
Citizenship: USA	Are you a contractor?	Yes:	No: X
Home Address: 5388 NW Lianna Way			
City: Portland	State: OR	Zip: 97229	Country: USA
Corporate Level Group: TMG	Division: ATD ___ ATM ___ CR _X__ CTM ___ CQN ___ FSM ___ LTD ___ MTO ___ PMG ___ SMTD ___ STTD ___ TCAD ___ TME ___ Other _____		
Supervisor: Ken David	WWID: 10038967	M/S: RA3-252	Phone #: 613-6620

Last Name:	First Name:		M.I.
Intel Phone Number:	Intel Fax Number:		Mailstop:
E-mail address:			WWID:
Citizenship:	Are you a contractor?	Yes:	No:
Home Address:			
City: Beaverton	State:	Zip:	Country:
Corporate Level Group:	Division: ATD ___ ATM ___ CR ___ CTM ___ CQN ___ FSM ___ LTD ___ MTO ___ PMG ___ SMTD ___ STTD ___ TCAD ___ TME ___ Other _____		
Supervisor:	WWID:	M/S:	Phone #:

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

REDACTED

10. **Explain the problem being addressed by the invention:**

This invention addresses the problem of:

1. Particle generation in heated immersion electroless Co bath
2. Particles generation in electroless Co bath during mixing the bath
3. High leakage due to particles deposited between the lines from the electroless bath with particles
4. High defects due to particles deposited on the wafer from the electroless bath with particles

11. **Explain current state of the art (i.e, how the problem is solved today):**

Presently the problem described above is solved by:

There is no solution demonstrated to eliminating particles generated in the electroless plating bath if immersion plating is used. The best results were obtained by using a POU spray process. POU spray electroless metal deposition uses on-line mixing of stable electroless solutions to generate unstable electroless plating bath and on-line heating of unstable electroless plating bath. However, during heating of unstable electroless plating bath overheating can occur and particles will be generated. Besides, on-line heating is typically taken several minutes (time to flow through on-line heater) and particles will be generated during this time in the volume of plating bath and deposited on the wafers surface.

Explain technical advantages of the invention over current state of the art:

The technical advantage of this invention is:

1. POU of use mixing is used to avoid bath life issues (particles generation and plate out) with recirculated immersion bath
2. Particles are eliminated also by the way of electroless plating bath is mixed and heated. Room temperature electroless Co bath is added to hot water thus during mixing electroless Co bath is diluted and only hot water is used for heating (avoiding use of in-line heater which can overheat plating bath)
3. Yield is increased due to leakage current reduction (metal particles causing leakage between lines are eliminated) and defect reduction (particles are not deposited on the wafer surface since particles are not generated in the plating bath)
4. Cost of the process is decreased since no in-line or immersion heaters are needed

13. **a. Is the invention experimentally verified? YES**

Heating of plating bath by adding electroless bath to hot water and plating in heated diluted electroless Co bath has been demonstrated in WE lab

b. Is the invention verified with simulation? No

c. If neither a. or b. above, then you can get a patent on the concept, but please explain the technical basis to justify that your invention will work (use extra space if necessary):

Detailed Description of Invention (try to use only the space provided with font #10 or larger type. Refer to your drawings):

Invention can be practice by using the following process steps:

1. Concentrated electroless Co bath is maintained at room temperature in the recirculated/filtrated holding tank (or pressurized canisters). Electroless bath can contain Co (as well as other elecroless metals to be plated such as Cu, Ni, Fe, Ag, Au, Pt, Pd, Ru others); complexing agents such as citric acid, EDTA others; buffer such as NH4Cl, boric acids others; pH adjuster such as KOH, TMAH others and reducing agent solutions such as DMAB, hypophosphite, formaldehyde, glyoxylic acid others. It can be 5x+ more concentrated bath to be mixed and diluted with water vs immersion electroless Co bath.
2. Pre-heat lines, chamber and wafers with hot DI water (70-100C). Surfactant can be added to DI water to improve wettability. Surfactant can be used such as RE 610, Triton X100, polyethers, polyoxyethylne etc.
3. Point-of-use mixing and heating concentrated electroless Co bath with hot DI water. Hot DI water and concentrated electroless Co bath can be mixed in 1 (H2O):1 (EL Co) to 10(H2O):1(EL Co) ratios depends on the concentration of ingredients in the concentrated electroless Co bath
4. Dispensing hot diluted electroless Co bath on the wafer. One of the embodiment can include mixing and heating hot DI water and concentrated electroless Co bath directly on the wafer
5. Providing adequate flow of diluted heated electroless plating bath (100 ml/min – 10 l/min) and rotating wafer (wafers) with >10 rpm in the process chamber to always have supply of fresh unstable electroless plating bath
6. Drain of unstable electroless plating bath
7. Rinse and dry wafers

Apparatus for electroless plating containing POU mixing system of concentrated electroless solution (solution is in the pressurized canisters or recirculated/filtrated plating tank) and hot DI water, enclosed and pressurized process chamber with rotated wafers; drain system; wafer handling system and automation.

Referenced sketches/dwg's/diagrams: (use additional page(s)

Drawings (use as many pages as needed)
(PLEASE DO NOT MAKE COLOR DRAWINGS)

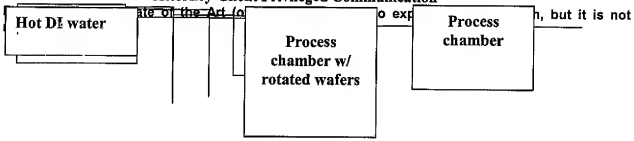


Figure 1. POU mixing of electroless bath and on-line heating

Figure 2. Schematic diagram of invention

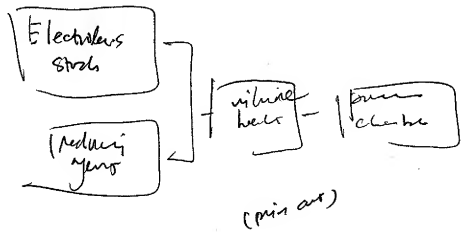
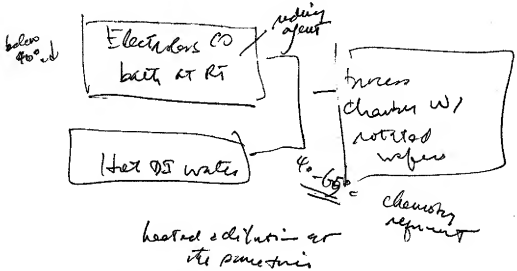


Figure 2. POU mixing and heating concentrated EL Co bath and HOT DI water



g Data (1 page limit on separate page):
12-15

17. What is the product or process invention to be used on? (e.g., P8xx, name of product, etc.):
P1266+

18. Have you reviewed your invention with a TMG Patent Mentor? (see below for mentor names) If so, give name: Ken Cadien

19. Any other information the IP Committee should consider?
Enabling IP to eliminate particles in electroless plating process

MENTOR REVIEW

If you don't already have a departmental peer review process for invention disclosures, we recommend you have it reviewed by a Mentor before you submit your invention disclosure. The purpose of this Mentor review is to ensure that the invention disclosure is written clearly enough for the IP Committee to comprehend your invention including all the novel aspects of it. Please refer to the list below for recommended Mentors by area. Select ONE Mentor to review and acknowledge. This recommended step is not meant to unreasonably slow down the invention disclosure process. If your Mentor fails to respond to you in a reasonable amount of time, then submit your invention disclosure.

AREA OF EXPERTISE	MENTOR NAME
Semiconductor Process-device and integration	Mark Bohr, Robert Chau, Krishna Seshan, Valery Dubin
Semiconductor Process-thin films	Ken Cadien, Chien Chiang, Michael Goldstein
Semiconductor Process-etch/litho	Peter Silverman, Peter Charvat (etch), Yan Borodovsky (litho), George Chen (litho), Susan Holl (litho)
Fab Process Equipment	George Chen
Circuits Design	Ian Young, Greg Taylor, Clair Webb, Rajesh Galivanche
Flash	Manzur Gill, Krishna Seshan
Test	J.J. Grealish, Rajesh Galivanche, Mike Mayberry
CQN (Q&R)	Ian Young, Greg Taylor, Clair Webb, Valluri (Bob) Rao
Software/CAD	Vivek Singh, Changhong Dai
Packaging	Ravi Mahajan, Vijay Wakharkar
Boards/Cartridge	Terry Dishongh
Automation	Ross Giddings
Optical and MEMS	Valluri (Bob) Rao, Ted Zarbock, Charles Young, Kevin Reif
Legal Department Patent Attorneys	Rob Winkle, Mark Seeley, David Lundmark, George Chen (patent agent)

New Client / Matter Fo. .n

Date	9/23/2003	○ NEW CLIENT	Client	110348
Prepared By:	af	◉ EXISTING CLIENT	Matter	110348-134848

CLIENT INFORMATION

Client Model: *	
Client Name 1: *	INTEL LEGAL - PPG/TMG-PROCESS
Client Name 2:	
Address Line 1: *	INTEL CORPORATION
Address Line 2:	DAVID SIMON
Address Line 3:	CHIEF PATENT COUNSEL
Address Line 4:	C/O MALOU DE LEON, SC4-203
Address Line 5:	2200 MISSION COLLEGE BLVD
Address Line 6:	SANTA CLARA, CA 95052
City:	SANTA CLARA State: CA
Postal Code:	95052 Country:
International Prefix No:	Phone No: (408) 765-6886 Fax No:
SS/Tax ID:	
Contact Name:	
Contact Title:	
Contact Email Address:	
Domestic / International:	D Add To Timekeeper's Contact List:

Notes: THIS ONE IS DIFFERENT THAN ALL THE OTHER INTEL FILES SO PLEASE NOTE THE SPECIAL INSTRUCTIONS: Please create a legal size redweld (containing the inserts requested on the last page of this form) ...Also, I need a trifold created with a colored barcode sticker and white barcode sticker on it. Please check all of it out to CJL but deliver to me. Thanks.

WFM_619

New Client / Matter Form

MATTER INFORMATION

General Information

Model Matter: 110348-134668

Matter description: * P17805 - IN-LINE PROCESS CONTROL OF POINT-OF-USE (POU) ELECTROLESS PLATING TOOLS

Practice: * 110 Patents and Trademark Alpha Code: PT

Billing timekeeper: * TFH Timothy F Haslach

Location: * 01 Portland

Supervising timekeeper: * CJL Lewis, Christopher J

Collaborating Atty.(s):

TFH	Haslach, Timothy F
CJL	Lewis, Christopher J

Court / Case No:

Date of Service:

Claim No:

Date of Injury/Date of Loss:

Opposing Counsel:

Domestic / International: D

Billing address (if different from client address):

International prefix No:

Phone No:

Fax No:

Contact Name:

Contact Title:

Contact Email Address:

BUSINESS / BILLING INFORMATION

Business Review Information

Add Client To New Contact List:

Description of Client Business:

Source of Business: * Other

Add Referral Source To Contact List:

Explanation:

Address:

City / State / Zip:

Phone No:

Anticipated Fees / Costs:

Client's Obligation:

Retainer:

Regular Billing: M Monthly

Fee Arrangement: * H Hourly

Contingency Fee Board *

Contingency Fee Accounting *

Budgeted Fees:

Notify at (%):

Budgeted Costs:

Notify at (%):

Fee Agreement / Engagement Letter:

Mandatory Credit Check Exception Request (State Reason):

Check if you DO NOT want automatic managing partner's welcome letter sent ☑

Billing Information

Use Billing Format: *

Other Reference (please specify):

Will you be using standard rates on this matter? * Y

New Client / Matter Form

RELATED PARTIES INFORMATION

First Name:
Last Name/ Company Name: *
Role status (C/A/O/P): * Rel. code: *
SS/TaxID: Type 1: *
Addl. Description: *Number of Records:*

First Name	Last/ Company Name	SS/Tax ID	R	Rel	Type1	Addl Description
	INTEL CORPORATION		C	CLI	BUS	

Batch ID 33143 No Possible Conflicts Found

Conflicts Search Action #1 * Brothers, Randi 9/24/2003

Conflicts Search Action #2 * Cliff, Michelle M. 9/24/2003

Approved:

- ☐ Closed - No client secrets or confidences held relevant to new case
- ☐ Different Parties
- ☐ Waiver obtained
- ☐ Other

Conflict Reviewed By *

Practice Group Conflict Review * Cohen, Michael 9/24/2003

New Client / Matter Fo. .n

APPROVALS & FINALIZATION / RECORDS

Approvals & Finalization

Practice Group Approval * Cohen, Michael 9/24/2003

Practice Group Comment

Record Center Signature * Cliff, Michelle M. 9/24/2003

Requested Client No. 110348

Requested Matter No. 110348-134848 9/24/2003 10:41:51

Records

Number of Folders: * 1

	Folders	Bar Code
1		
2		

	Inserts	Folder No
1	PINK SHEET	1
2	DISCLOSURE	1
3	CLIENT CORRESPONDENCE	
4	PTO CORRESPONDENCE	
5	WORKING APPLICATION	1
6	TRIFOLD	
7	ATTORNEY RESEARCH	
8	REFERENCES	
9	SCHWABE CORRESPONDENCE	
10	DRAWINGS	1
11	CHECKLIST & FORMS	
12	<NULL>	
13		
14		
15		
16		
17		
18		
19		
20		

	Inserts	Folder No
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		